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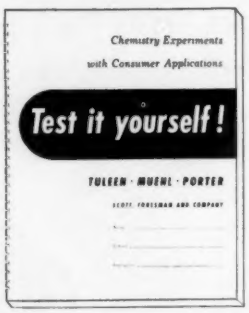

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Science Education in a Democracy*

OSCAR RIDDLE

Carnegie Institution of Washington
Station for Experimental Evolution
Cold Spring Harbor, New York

SCIENCE, education and democracy are now suffering so much from some decades of unwarranted optimism and easy drifting with the current that these few remarks may more profitably deal with failure than with success.

I

Of course, scientists and many others are much impressed with the grandeur, power and surpassing human importance of the accomplishments of science. But equally impressive just now is the failure of scientists and educators everywhere to acquaint any people with even those fundamentals of science which would permit them to place their lives, aspirations and institutions on a basis of reality. I name three such principles:

1. Natural law rules throughout the world in and about us.
2. Man is a higher animal.
3. All men are created genetically unequal.

CERTAINLY, we in the United States have accomplished none of these things; nor, in the speaker's opinion, are we likely to accomplish any of them soon. Both scientists and educators are unprepared, or unwilling, or unready, or uninterested or otherwise undedicated to this task. I here cite an item of evidence. An indication of the degree of interest of American scientists is provided by the following incident. A couple of years ago the American Association for the Advancement of Science — of which this group is a part — held a Symposium on "Science and Society." The place of science in education was not scheduled in that Symposium nor was it presented. And now a similar item concerning educators. That the educators of this country are in fact but little interested in this situation is indicated by the printed results of a Congress on Problems of Democracy held 17 months ago under auspices of educators at Teachers College, Columbia University, New York. Here are a few details on that Congress as its work was reported and published in The New York Times, Aug. 18, 1939: None of the 16 divisions or "seminars" of the Congress dealt with the place of science in either education or democracy. In the first of those 16 summary reports we find the biologically doubtful or impossible statement that "We agreed also that a democracy affirms the educability of all men, etc." In the last of those seminars, dealing with "What Shall Be Done," it was proposed that a "continuation committee" be appointed but among the several broad topics relating to American democracy which were suggested for consideration there was no such thing as the place of science in American education or democracy. This group of educators did there express concern about the "religious instruction" of youth — a thing which we had supposed to rest outside the schools — but they left no record of concern for

* Read as a part of a symposium on The Place of Science in General Education, Philadelphia, Dec. 30, 1940, on the program of the American Science Teachers Association.

the place of science, whose only possible home is in the schools.

II

THE LAYMAN and thinker, John Ruskin, gave us the following simple and clear statement about science: "The work of science is to substitute facts for appearance, and demonstrations for impressions." At that moment Ruskin was content to ignore the further work of science — the discovery of interrelationship between phenomena. Since "appearance" and "impressions" so often fail to correspond with facts and demonstrations, it is obvious that science has a lot of work to do — on people.

In considering an educational program for any and all of the children he knows a naive biologist would suppose that after some six or eight years of learning such things as reading, writing, geography, arithmetic and American history, the youth would need to begin in earnest — using as much as two-fifths of his school day — to substitute facts for appearance, and demonstrations for impressions, of the world about him and of his own body and mind. Yes, the naive biologist would suppose that after six or eight years of preliminaries the school which seeks to educate — rather than to entertain — might accept as nearly half of its task the job of building better minds in better bodies; this both for the personal advantage of the youth and for the good and safety of self-governing peoples who must live together. But, obviously this would mean a lot of science teaching at the high school level. Obviously the present supply of such teachers is quite inadequate. Obviously this supply cannot be recruited, since that would mean displacement of teachers of other subjects. Obviously tradition, status quo, much of present educational pattern, and vested interests of a dozen kinds, prevent marked change in that direction. And obviously, in the near future, only small changes and perhaps a changed attitude in certain quarters is the most we dare expect.

III

THAT SCIENCE is but lightly represented in the high school training of our youth is only part of a vexed situation. Part of the science that is taught there is poorly or shamefully taught. Sometimes there is paralyzing lack of equipment, and sometimes the teacher is equipped mainly with paralysis. Since I am more familiar with conditions affecting the teaching of biology I will cite evidence or illustrations from that science which deals with protoplasm — protoplasm whose finest fruits are 2,000,000 living species and ideas without number. The evidence concerning the quality of much of current teaching of biology is just now available from questionnaires returned by 3,200 biology teachers in secondary schools of the United States to a Committee of which I chance to be the chairman. We cite the following items from among many items learned from that questionnaire:

Only 53% of 2,931 biology teachers who replied to this question said their special preparation was for teaching biology.

Only 69% of these teachers utilize rooms especially arranged for biology teaching. And some of this teaching is done in unprepared rooms not only in rural places, but also in Philadelphia, New York, Chicago, St. Louis, etc.

MOST TEACHERS indicate that their college courses in biological subjects did not properly equip them with the subject matter required in high school teaching.

For 39.4% of biology teachers extra-curricular school activities interfere much or seriously with their teaching.

From public schools of all American cities of more than 100,000 population 50.6% of teachers report that their classes are oversized — 34 or more per class. Here in Philadelphia all of 13 teachers, or 100%, report such oversized classes; and 82.3% of these average more than 40 pupils per class.

(Continued on page 26)

Should Science Teaching Be Changed*

JOHN A. TIMM

Presented Before American Science Teachers Association Philadelphia, Pennsylvania

ELEMENTARY science courses in general and particularly those in the physical sciences have always been more or less unpopular with liberal arts students. Science teachers have explained this lack of interest by pointing out the inherent difficulty of the subject matter and by assuming that a fundamental intellectual laziness or perhaps a blindness to science characterizes the average liberal arts student. Within the last decade, however, such a persistent barrage of adverse criticism has been leveled at science instruction that teachers have been forced to consider both the content of their elementary courses and the methods by which they have been taught.

THE TRADITIONAL type of course in elementary chemistry was conceived by the great teacher, Justus von Liebig, at Giessen early in the nineteenth century. At hat time and during the greater part of the century chemistry was primarily a descriptive science. Its concepts were almost as many and varied as the number and interests of its investigators. Its philosophy began to crystallize only after the first seventy years of the century had passed. The organization of the subject matter of the elementary course was built around an orderly presentation of the facts. When theoretical chemistry matured under the masterful guidance of Wilhelm Ostwald, these concepts were introduced one by one into the already overcrowded course. It has appealed, therefore, only to those students in whom an intellectual stamina has been nurtured by a lively interest in science. Further, many of its descriptive facts represent useful knowledge only to the professional chemist and can scarcely be considered vital by the average liberal arts student. The great majority of the students taking such a course have emerged bored and even definitely antagonistic. Among these have been a few who have subsequently become teachers in other fields. These have been able to make their protests heard. Their reasons for demanding a change have been valid but their suggestions as to the direction which such a change should take have been colored by the glowing descriptions of the achievements of chemistry which appear so frequently in newspapers and magazines. We can state the substance of their suggestions perhaps with some exaggeration as follows. If John could be taught the physics of the correct golf swing, and Mary the chemistry of the most durable and yet most fetching lip-stick, boredom would vanish and the country be enriched by a harvest of intelligent consumers.

SCIENCE TEACHERS are particularly conscientious and this adverse criticism has had a salutary effect. Each teacher has asked himself wherein he has been at fault and the answers given have fallen into three schools of thought. On the right flank are those who place the blame primarily on the students and on their secondary school training. To them this younger generation is in a bad way — lazy, frivolous, interested solely in listening to swing bands on the radio or in looking at Hollywood-on-parade in the movies. It seems to these teachers that, if the demand for a different type of science course for the liberal arts students were acceded to, the result might be entertaining but could scarcely compete with the movies in this respect. Certainly its educational value would be nil. Therefore, they conclude that the mental discipline of the traditional type of course is, as it always has been, the medicine which the liberal arts students

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AMERICAN SCIENCE TEACHERS ASSOCIATION

IN KEEPING with our service policy to national and state associations we are publishing in this issue material presented at the regular meeting of the American Science Teachers Association, a national organization of science teachers affiliated with the American Academy for the Advancement of Science. This material is carried only in part due to the fact that not all was available at this time. We are glad to perform this service as a matter of preserving it for use of association members and also to pass the good things on to our readers.

The American Science Teachers Association is filling a unique place in tieing together the research workers in pure science with the teacher, who is attempting to present science to the coming generation of science workers. Each can profit by direct contact with the other and can learn to appreciate what the other is doing.

ILLINOIS SCIENCE MEETINGS

THE HIGH School Conference coming in November again offers a varied and challenging program in both the physical and biological sciences. We note that the Illinois Association of Chemistry Teachers meeting with the Conference offers opportunities for teacher growth through the presentation of new ideas. In fact, one of the papers to be presented deals with this topic directly. (See program in this issue.) The noon luncheon, which has become a tradition of this group, will no doubt be as well attended as usual

The Illinois Association of Biology Teachers, under the leadership of Miss Madeline Dague, president of the association, have arranged some very outstanding numbers for the Urbana meeting. Especially challenging is " A Mind Mislaid" by Mr. Henry Collins Brown, founder of the New York City Museum.

Needed--A Strong National Association

EDITORIAL

THE OFT repeated statement, "In unity there is strength," applies as well to science teachers as it does to all of us in America in our effort toward defense. We are just beginning to appreciate the need for unity in the matter of foreign policy in order to make our will effective. Lack of it produces weakness, and ineffective effort. Cooperative effort of people — workers, factory owners, and statesmen — wins.

As to science teachers, unity of action on a large scale is not only necessary but desirable in developing an adequate science program, meeting science teachers' needs, and overcoming administrative obstacles. At present science teacher organization, though making progress, is far short of the ultimate goal. Some states do have very active groups, but in others there is a woeful lack of it. While among states there is anything but effective teamwork.

The logical course of action among science teacher groups is to get together and begin working in larger units. There is little reason that our thinking remain in the horse and buggy state in regard to organized effort. Rapid transportation and communication has annihilated both time and distance and has brought the most distant so near that it is easy for representatives of every area to get together, talk over, and act upon our common problems. We need to develop either strong regional associations or a strong national one.

AT PRESENT the organized groups that offer the best opportunities for united effort are the American Science Teachers Association and the Science Council of the National Educational Association. The former has made much progress in securing cooperation among science teacher groups. At present it has some eighteen groups, state and regional, that have affiliated with it. This association in turn is affiliated with the American Association for the Advancement of Science. Among its objectives as stated at the time of organization are the very laudable ones of developing a satisfactory science program in both the grades and high school, securing organized effort in meeting teachers' problems, and providing a clearing house for information for science teachers. Among those active in sponsoring the association when it was organized were Harry A. Carpenter of the Rochester Public Schools of New York, Professor Otis Caldwell of Columbia University, and Professor Hanor Webb of Peabody College for Teachers. They are still active in its support and deserve much credit for what has been accomplished to date.

The Science Council of the National Education Association has more recently gained impetus in its growth through expanded service to teachers. Its cooperative work on an adequate science program, which is soon to be completed, is especially to be noted. Among the present leadership much credit must go to Dr. Jack Hudspeth of the University High School of the University of Texas, president of the organization, and to Dr. Ira C. Davis of the University High School, University of Wisocnsin, chairman of the science committee.

THESE GROUPS are here mentioned because they are national in character, they attempt to serve all science teachers and they offer possibilities for further organized effort in the improvement of science education.

In building toward a strong national association it should not be overlooked that the real strength lies with the local, or state group. In it there are the greatest opportunities for many teachers to work. It is work, doing, not absorbing, that develops strength. Strong state groups, in turn, assure an active and vigorous national organization.

JOHN C. CHIDDIX.

Television*

Condensed from a talk by T. F. Joyce

RCA Electronic Research Laboratories

IN THE brief period that television was under way, from April 30, 1939 to March, 1940, there was secured enough merchandising and programing experience with television to justify our looking ahead confidently to the day when all of the dreams that the television pioneers have had for this great invention will become realities. One of the pioneers who made great contributions to this development shares the platform with me this morning — Dr. Zworykin. It was Dr. Zworykin who invented the electronic eye of television — the Iconoscope — without which the all electronic system of television would not be possible.

In May, 1939, at the start of NBC's regular television broadcasts, I saw Dr. Zworykin in our lunch club. At that time, I said to him, "Doctor, how does it feel to have television at last get out into the open with a regular television broadcasting service?" The doctor looked at me in utter amazement and said, "Television? I forgot about television three years ago. I am now working on the electron microscope. Come down to my laboratory, one day, and I will show it to you."

SO, YOU SEE, a great scientific mind, having proved certain basic principles, leaves the new child in the hands of development engineers and business men to guide its destinies to maturity, while the great scientist moves on into other unexplored fields. Where the work of the scientist leave off, the work of the business organization begins. And the work of the business organization does not end until the invention no longer serves a public need. The responsibility of the business organization is to take the successful developments of the research workers and find ways of designing, manufacturing and selling the new devices at prices that the would-be buyers can afford to pay.

Like all of the great inventions that have come before it, television was not and is not a new idea. From the beginning, man has wished to be able to see beyond the horizon. As man's other desires became realities, so, too, his dream of being able to see distant events, as they are taking place, has become an accomplished fact. Between the dream and the accomplishment has gone almost a century of work by scientists in laboratories throughout the world — each knowingly or unknowingly contributing to the onward march of television.

IN 1847, Blackwell suggested the "copying telegraph" using a scanning method. Scanning, as we know, is one of the principles used in both modern television and facsimile.

Through the years, from 1847 down to the present day, there have been countless unsung engineers and scientists each of whom has tried to solve the almost insurmountable problem of sending pictures through the air. The number who have labored on this problem are evidence of the value they attached to the solution of the problem, and the ever present, silent though forceful, pressure of the human desire to have answered the age-old problem of seeing through space.

The Nipkow disc, a fundamental method of scanning, which was patented in 1884, long before apparatus was ready for using it. The idea of using a cathode ray tube for reproducing an image, was suggested in 1907, before vacuum tube amplifiers had been invented to operate it. That proposal, in a measure, could be compared to suggesting the construction of an automobile engine before a source of power, such as gasoline, was developed to run the motor. The cathode

* Presented on the program of the American Science Teachers Association, December 30, 1940, at Philadelphia.

ray tube, suggested in 1907 by the distinguished Russian scientist, Rosing, is the heart of today's television system. Incidentally, one of Rosing's pupils was Dr. Bworykin, Director of RCA Electronic Laboratories. It was Dr. Zworykin and his associates who were largely instrumental in the development of the cathode ray system of television, the system that is recognized as the standard not only of the United States, but in Europe as well.

IN 1924, Dr. Zworykin demonstrated the first crude picture using the all electronic television system, employing the famed Iconoscope or "television eye" to pick up the picture and the cathode ray tube or Kinescope to reproduce the picture on the other end. Dr. Zworykin had developed a system of television, without moving parts, which held great promise for the future. From then on the development of television moved forward at an accelerated pace. It became a question of perfecting and refining that system; not that this was an easy task. Another fourteen years of constant study, research and experiments by a large research staff and an expenditure of millions of dollars were necessary to bring television to its present state of perfection.

In 1928, RCA set up its first television transmitting station. In 1931, the location of this television transmitting station was changed to the top of the Empire State building, its present site. In 1932, television transmission of 120 lines was used and, incidentally, the pictures from the Empire State building were relayed to Camden via radio relay link. Each year improvements were made in the system until finally, in 1937, the present RMA standard of 441 lines was adopted.

In 1935, the man who conceived the present system of radio broadcasting, Mr. David Sarnoff, president of the Radio Corporation of America, decided that television should be taken out of the laboratory and given a thorough field test, with a view to proving its practicability for home use. We had seen laboratory demonstrations that were entirely satisfactory. But the question was: Will it stand up in the home? Sure, our engineers knew how to operate a television receiver, but what about John Doe and Mamie O'Rourke? Could they operate a television receiver? Could the television studio apparatus and transmitter be depended upon for reliable day in and day out service?

TO ANSWER these and other questions RCA spent $2,000,000 in a three-year television field test conducted in the New York area. One hundred television receivers were placed in the homes of RCA and NBC engineers and executives, and a regular schedule of television programs was begun. Friends of these engineers and executives were invited in to see the pictures and to operate the receivers. The receivers were not allowed to stay in one location. They were moved around within an area of approximately forty miles radius from the Empire State building. Out of that field test came a practical television receiver that is no more difficult to operate, and not much more difficult to service, than an ordinary receiver.

During that same period RCA engineers also developed a mobile transmitter, to be used in picking up outside events, such as tennis matches, baseball games, prize fights, et cetera. The pictures are relayed from this mobile transmitter to the main television transmitter on top of the Empire State building. There they are picked up and re-transmitted over the powerful RCA-NBC television transmitter.

IN THE fall of 1938 our engineers and commercial people were convinced that we had a system of television that was ready for public use. The picture quality, from the standpoint of definition and light, was equivalent to home movies. The detail was sufficiently clear to enable an onlooker to see a whisp of a hair

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Radio and the Biology Teacher

A. L. CHAPMAN*

University of Texas Austin, Texas

IT SEEMS a long cry from the ameba to frequency modulation; from crustaceans to Charlie McCarthy, but it may not be quite so far as might be supposed. As biology teachers well know, the child brings to school with him all of his experiences, his longings, his loves and hates, his aspirations, and his pleasant memories of out-of-school life. If the teacher could know all about these experiences he might do a better job of his teaching, but, alas, this is impossible. The teacher does know that his students are listening to radio programs. He knows that they listen to Jack Benny, Fibber McGee, Lux Radio Theatre. Some of the radio listening might be more useful if the biology teacher would call the attention of the students to appropriate programs that are related to the study of biology.

This article is being written during the summer, therefore, it is impossible to forecast the titles and content of the above mentioned "appropriate programs." However, it is reasonable to assume that radio programs this year are similar to the ones that were offered last year. For this reason it seems worth while to review the names of broadcasts, by national networks, relating to the study of biology. A representative sampling of programs suitable for out-of-school listening by biology students is listed below:

The World Is Yours. Dramas of world of science based on the exhibits and expeditions of the Smithsonian Institution. NBC, Red network in cooperation with the U. S. Office of Education and the Smithsonian Institution. Broadcast Saturdays, 5:00-5:30 p.m. EDST. The program for June 28th was titled "How Plants Grow." Some of the programs do not deal directly with biology.

Adventures in Science. Interviews with prominent scientists and reports of the latest news in the science field. CBS, Thursdays, 2:45 p.m., EDST. The commentator is Watson Davis, director of **Science Service.** The program for July 31 was titled "Hunting Dinosaurs."

Nature Sketches. Field trips in Rocky Mountain National Park described by Raymond Gregg, noted naturalist. NBC Red network, Saturdays, 3:00-3:15 p.m., EDST. The program for June 14 was titled "Flowers That Live with Snow."

Outdoors With Bob Edge. Talks and interviews on outdoor life. CBS, Thursdays, 6:15 p.m., EDST.

What's New at the Zoo. Descriptions of various happenings at a large zoo. CBS, Sundays, 11:30 a.m., EDST. John Reed King, commentator.

Doctors at Work. A dramatic survey of many facts of medical practice. NBC, Blue Network in cooperation with the American Medical Association, Wednesdays, 10:30-11:00 p.m., EDST. (Too late at night.)

March of Health. Deals with health problems. MBS, Sundays, 12:00 noon, CST.

Highways of Health. Medical talks for the layman. Arranged by the New York Academy of Medicine. CBS, Fridays, 4:15 p.m., EDST. The program for July 18 was titled, "The Sun and Your Skin."

* Director, Bureau of Research in Education by Radio.

Suggestions for Using Out-of-School Broadcasts

OUT-OF-SCHOOL broadcasts offer an opportunity for the biology teacher to suggest that the students listen to them at home during leisure hours. Most of these are interesting radio programs and the students will enjoy the experience. The value of the listening experience will depend upon the individual student and the extent to which the teacher is able to follow up the listening with class discussion at a later time.

The problem of the biology teacher is to find what science programs are available. Some teachers have found it helpful to get the students to organize into committees to prepare lists of recommended programs for other students. A weekly listening log posted on bulletin boards throughout the school may prove to be an incentive for all students to listen to some of the broadcasts, and, at the same time, it gives valuable citizenship training to those who have the responsibility for preparing the listening

log. Alternating the membership of the committee will give larger numbers of students an opportunity to participate.

STUDENTS CAN also be given the opportunity to write letters to local stations and regional and national networks asking for information and asking to be placed on the regular mailing list. Stations are anxious to cooperate with the schools. Since the programs are often designed to be heard by adolescents the stations want as many listeners as they can get

Some classes will also want to write those persons responsible for the program to offer suggestions. Students often take pride in evaluating the broadcasts according to criteria which the class has developed under the guidance of the teacher. This can be a valuable experience if the students don't get so engrossed with "fault finding" that they forget the positive values of the programs.

School Broadcasts

IN ADDITION to the broadcasts which the students may hear out of school, there are numerous ones designed for the students to hear at school under the guidance of the teacher. Although each locality will have different broadcasts, there are some which will illustrate the availability of programs suitable for biology teachers to use. Almost every local or regional "school of the air" has one series dealing with science. The programs listed below were broadcast during the 1940-41 school session, these or similar programs will likely be available during 1941-42.

Science. Broadcast by station WHAM Mondays, Tuesdays, Wednesdays, and Thursdays. These programs are a part of the Rochester School of the Air. The various series are designed for grades five through eight. The science program for May 12 was titled "Science Looks at Smoking and Drinking."

Afield With Ranger Mac. Broadcast by station WHA, Mondays. This is a series of the Wisconsin School of the Air. Although the programs deal primarily with nature study, biology teachers will find some of the programs quite useful. This series has a registered listening audience of over 30,000 during 1940-41. The program for May 5 was titled, "We Visit a Fish Hatchery."

New Horizons. Broadcast by CBS, Wednesdays, 2:30 CST. This is a series of the American School of the Air. During 1940-41 the series told the story of water in the discovery and development of the Americas. Roy Chapman Andrews, director of the American Museum of Natural History, presided over each program.

Science News of the Week. Broadcast by station KFKU, the University of Kansas, Tuesdays, 2:30 p.m., CST.

Suggestions for In-School-Listening

Preparing Students for Listening. To use most school broadcasts effectively, it is desirable to prepare the students for effective listening. If the students don't know clearly just what is to be the purpose of the program, a few minutes should be spent in familiarizing the students with the nature of the program. In radio it is almost impossible to know just what will be the exact content of the program in advance. The general "mind set" of the students is more important than knowing what will be in the program. In addition to the pre-broadcast discussion the teacher can enhance the value of the listening by his enthusiastic and attentive attitude. If guide sheets, exhibits, or other materials are to be used during the listening period the listening group should be acquainted with what is to be done during the broadcast.

THE MATERIALS for use in the preparatory, listening, and follow-up activities are found in most teacher manuals of the series which is being heard. Most of the programs which are designed for in-school listening are planned some time in advance and are accompanied by teacher manuals for the assistance of the teacher in preparing the students for the listening and follow-up activities. The teacher manual can be secured from the station which broadcasts the program.

In short, it is the task of the teacher to furnish some understanding of the purposes of the program and to create a pleasant anticipation of what is to come.

(Continued on page 33)

Science for Society

EDITED BY JOSEPH SINGERMAN

● A department in which science is presented in its close relationship to the individual and in which guidance is given in causing the individual to recognize the methods of science and its vast social implications.

Science Versus Life

ANTON J. CARLSON

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(Continued from April issue)

This concludes the text of the Annual Sigma Xi lecture delivered at Philadelphia, December 30, 1940. In the earlier part of his address, published in the April issue, Professor Carlson absolves science from any blame for present worldwide ills; and indicates rather forcefully, that this is not an age of science; for man, by and large, has not gone beyond the jungle stage in habits of thought and behavior.

"Post Hoc" Reasoning

IT IS STILL a common practice of man, so-called civilized man, to follow "post hoc" reasoning; that is, because one event may sometimes follow another, the two events are therefore necessarily causally related. Mankind as a whole, and even leaders in business, industry, and government, do not yet thoroughly understand or follow the principle of control, the principle of experiment. "Post hoc" reasoning is one of the comomnest sins against the scientific method, and we still see it occasionally in those who have been trained in science; for example, modern physicians. It is apparently very easy to lapse into the primitive and time-honored way of thinking, the "post hoc" reasoning. As an example of "post hoc" reasoning in medicine, I can cite the case of a physician who had practiced medicine honestly in a far western state for forty years. A number of years ago, he told me in all seriousness that he had discovered a specific remedy for influenza. I was naturally curious, because influenza is one of the maladies which has so far largely defied modern scientific control. On being asked what his remedy was, he replied, "Good whiskey and plenty of it." The doctor was apparently perfectly sincere about it. When I asked him how many influenza patients he had treated without whiskey and how many of these recovered, he looked at me in surprise and said: "You understand, I have treated every one of my influenza patients with whiskey during the last forty years, and I have had a high percentage of recovery." This physician, though stupid, was too honest and venerable to poke fun at. I was tempted to ask him how many recoveries from influenza he thought he would have had if he had had them read Mary Baker Eddy's "Science and Health" at an angle of 45 degrees, practised Coueism, or had their spines or toes twisted according to the chiropracter's cult. Another example is that of another honest physician in a southern state using a remedy whose virtue, if any, was essentially twenty per cent alcohol, a so-called female tonic, a southern counterpart of a well-known vegetable compound. The case was that of a young girl working twelve hours a day in a factory in a southern city at low pay. She lived in a garret room, with poor feed, and poor sanitation. She had a high degree of anemia. The doctor wrote: "I took this girl out of the factory, sent her to the country for three months with relatives and gave her this female tonic. After three months she had nearly recovered from her anemia, thanks to this tonic." It is not surprising that even physicians fall into this error of reasoning, because in the not distant past medical education was only partly scientific.

To What Extent or in What Sense Is Science in Conflict with Society?

I THINK there is much confusion, misunderstanding and unwarranted generalization on this point. Not so many years ago the American Association for the Advancement of Science declared, by resolution: "Science is wholly independent of national boundaries, and races, and creeds and can flourish only where there is peace and intellectual freedom." This position is clearly in conflict with the cyclical psychosis exhibited by homo sapiens, in mass, throughout the ages. But whether there is a conflict of science with the primary interest and ultimate well-being of society is at least an open question. Only last year an outstanding physicist declared: "Science makes man human."I presume our colleague meant that science tends, or should tend, to make man more human. The possible conflict between science and society in this statement obviously depends on our conception of what are the desirable human qualities, or behaviors, today and tomorrow. If they are deceit, violence and war, there is a conflict between science and society, for deceit violence and war are the very antithesis of the scientific method.

Two years ago a colleague uttered the following dictum: "Here on this continent where science has achieved its greatest application, science is in conflict with society. Science and technology have gone so far that the present social structure is facing its debacle. Nowhere else in the world today is science in such militant conflict with the social structure under which science survives." The same author also speaks of the prostitution of science for war." We have here, clearly, a confusion of science and the scientific method with the uses, largely by a nonscientific society, of the understandings and the gadgets developed by the methods and the applications of science, for satisfactions of the ancient human drives of greed, hate, and vanity. The modern use of scientific gadgets and forces for violence and war is not essentially different from the ancient use of the hand, the teeth, the rock, the stick, and the club in similar drives by our primitive ancestors.

Conflict Based on Misunderstanding

THE PRESIDENT of the United States recently addressed a letter to the president of the Massachusetts Institute of Technology, calling upon the engineering profession to "cooperate in designing accommodating mechanisms to absorb the shocks of the impact of science on society." It seems to me that here, again, we have a confusion of the scientific method and science with technology, and an identification of science in general with the scientific achievements in chemistry and physics. Is it not the technology developed through the latter achievements with which our President is concerned? Evidently the President, though he said so, did not really mean science in general or the scientific method. If our fellow citizens really are shocked by new data, new generalizations, new uses and controls of matter and energy, new understanding of man and the universe brought forth by science, what kind of shock absorber would he suggest against such new knowledge and would he not agree that those who are shocked by these new understandings should be so shocked? For instance, what kind of shock absorber for society may we look for in the matter of the biologic and medical sciences and the services of modern medicine, especially in prevention and control of infections and the application of modern knowledge of nutrition? To be sure, society once appeared to be shocked by the theory of the evolution of life, and the growing evidences of the unity of all life. These facts do disturb some people, but in my judgment that disturbance is wholesome for society. However, the science of modern biology and medicine certainly helps to preserve and to prolong the life of the least fit members of society, least fit physically and mentally. Biology and medicine have

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Science Clubs at Work

EDITED BY KARL F. OERLEIN
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A department devoted to the recognition of the splendid work being done by the science club members and their sponsors in the various State Junior Academies of Science. Material for this department, such as student made projects; demonstrations and posters; outstanding club programs; state and regional meeting announcements; should be sent to Dr. Oerlein.

Kansas Junior Academy of Science

A BRIEF HISTORY

(Editor's note: Miss Edith P. Beach, Lawrence, Kansas, is responsible for this material. The editor gratefully acknowledges her aid in supplying the material on the Kansas Junior Academy of Science.

The next issue will feature the Kentucky Junior Academy of Science. Dr. Anna A. Schnieb, Eastern Kentucky State Teachers College, has graciously consented to prepare the material.)

AT THE ANNUAL meeting of the Kansas Academy of Science, in April, 1930, a committee was appointed to organize a Junior department. The first meeting of the Junior Academy was held at the University of Kansas, April 24, 1931. At this meeting, officers were elected and a permanent organization was formed. Annual meetings have been held every year since in conjunction with the Senior Academy meeting. The program consists of student talks, demonstrations and exhibits.

By 1940, the number of schools participating had become so large that the general committee decided to divide the schools into A and B groups, the A groups consisting of high schools with an enrollment of 300 or more. The smaller high schools and junior high schools are included in the B section. Rotating loving cups are given each section as first group awards for the best program as a whole and the best school exhibit. The cup becomes the permanent property of any school winning it three years. First, second, and third place individual awards are also given for the best talk or paper, demonstration and individual exhibits. These awards consist of medals, pins, and ribbons. The A.A.A.S. honor students are also chosen at the annual meeting.

THE TENTH annual meeting of the Kansas Academy of Science was held at Manhattan, April 4, 1941.

The Kansas Junior Academy publishes a bulletin, the "Science News Flashes." The "Transactions of the Junior Academy of Science was gotten out last year in bound mimeograph form, and copies were sent to all clubs that are members of the state organization and other interested groups.

Officers for 1941-42:

President—John Michener, Wichita.

Secretary—Ray Trockmorton, Manhattan.

A.A.A.S. honor students:

Robert Beck, Manhattan High School.

Frances Chubb, Lawrence Junior High School.

In the 1940-1 school year there were thirty clubs that were active members.

Among them were the following:

Argentine Biological Science Club, Wyandotte High School, Kansas City, Kansas
Atchison Junior High School, Atchison
Ben Franklin Club, Memorial High School, Lawrence
Burlington High School, Burlington
Caldwell High School, Caldwell
Clay Center High School, Clay Center
Cherryvale High School Science Club, Ch'ryv'le
Dellinger Junior Science Club
Ellinwood High School Science Club, Ellinwood
Galena Junior High School, Galena
Gridley Rural High School, Gridley
Holiday Junior Science Club, Topeka
Independence General Science Club, Independence
Junction City High School, Junction City

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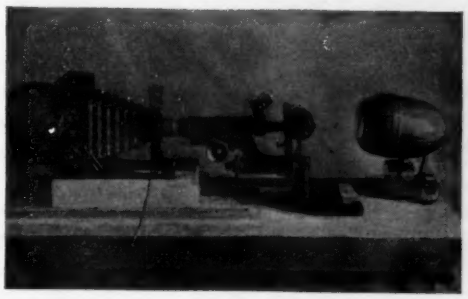
Photomicrography As a Project

KENNETH BOHANNAN
High School Student
Cedar Vale High School Cedar Vale Kansas

IN OUR SCHOOL we have only one microscope, but we have a very good selection of prepared slides. This situation presented a problem. We had plenty of material to examine, but no method to present it for class room observation. By the time thirty-two students have examined one field on a slide, one half of the period is over. This procedure proved to be a very inefficient one. When photographs through the microscope was suggested as a project I chose it because it seemed to offer a solution to a definite problem.

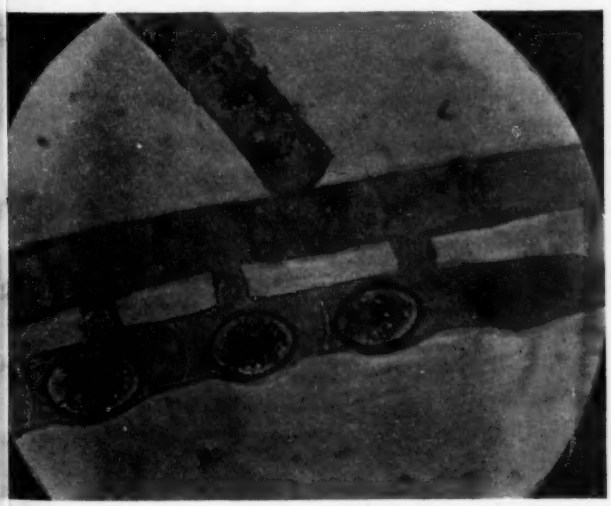
Photographs through the microscope would be valuable supplements to direct microscopic examination. While the student awaited his turn to examine a particular field under the microscope, he could be looking at an actual photograph of some other portion of the same slide. The teacher could also point out and demonstrate structures on photographs because they can be handled.

THE APPARATUS necessary consists of a camera, a microscope, and a light source. On my particular set-up I used a Taxo camera because it has a ground glass focusing back. I might add that any kind of camera can be used, including the common box camera. The light source was furnished by a 60 watt clamp-on bed lamp, which was purchased for fifty cents. The problem was to line these with a microscope so there would be no vibration. The magnification is rather high, and the smallest movement is disastrous to the picture. The light was fixed at one end of a baseboard. The microscope was bent so that the barrel was parallel with the baseboard. The camera was then fixed on a base that could be slid along the baseboard between guide strips. A lead collar was made to shut out all light from between the ocular lens and the camera lens. The light was now allowed to pass through the slide, through the barrel, and into the camera.



Equipment for Making Photomicrograph

Photomicrograph — Conjugating Spirogrya — 200 x's



A LITTLE experimentation was necessary to determine the correct exposure time. By trial and error I found three seconds for low, and six seconds for high power to give best results when using fast film such as Super Pan Press or Super Panchro Press. This time was varied slightly depending upon the type and density of the stain used on the slide.

Cacti*

GEORGIA HOFFMAN

College High School Student Pittsburg, Kansas

AS PART of our course in biology each student is required to write a term theme. He may choose any subject in which he is particularly interested. The subject that I have chosen is Cacti. This subject was chosen because of my special interest in them. I have noticed living specimens in a novelty shop. Their green fleshy stems covered with brown and white thorns attracted my attention. These appealed to me as something different from the ordinary ferns and house plants. My theme and project are of great value to me. My project serves as a hobby or an avocation, also creates an incentive to do more reading and to be more alert for new material about these queer plants.

Cacti embrace a family of prickly or spiny plants that have usually inconspicuous but modified leaves. Sometimes the plants are very fleshy and thickened, often globular or cylindrical stemmed. The flowers grow in clusters and in many cases are found solitary and very showy.

THERE ARE many outstanding characteristics of cacti. The most precious thing in the desert is water. Everything that inhabits the desert must learn not to want too much water to drink. The cactus has worked this out in a very interesting manner by giving up the making of leaves and building its stems in such a way that very little is exposed to the direct rays of the sun, which acts to make the plant give up its moisture. You who are scientists know are their colors and various sizes. Almost every kind of cacti is green or has a green background covered with spines. They vary in height from two inches to fifty feet and diameter from two inches to three feet. Cacti are self protecting. They protect themselves from animals and birds by their spines and long fine glass-like hairs. A very small root system is a general characteristic of all cacti. The climate in which they grow should be hot and dry, although in some cases the prickly pear lives in a land where the temperature gets below zero. They thrive in very thin, sandy, and rocky soil.

There are over two hundred and twenty-five species of cacti found in the United States. The state of Arizona contains over one-tenth of all the cacti on earth, about one hundred species being native to it. Only forty or fifty species of cacti are known to be under cultivation. Texas and New Mexico are two other leading states in the distribution of cacti.

Cacti are found in other countries all over the world. The prickly pear is a native of Canada, Australia, South America, and Northern Africa. Other species of cacti are found in Europe, the West Indies, and the Canary Island. I have a map showing the distribution of cacti all over the world.

THERE ARE many differents kinds of cacti. The following descriptions indicate the great differences among them.

The prickly pear grows to be two or three feet high and about two inches wide. The leaf, as it is called, is the shape of the palm of the hand covered with small spines invisible to the eye. The blossom is salmon pink. It grows from the top of the leaf. When the blossom drops off, a fruit in the shape of a pear is formed. It has a dark purple pulp

This project was demonstrated with a collection of twenty living plants which were described. A large scrapbook of information, including clippings, descriptions, snapshots and pictures of beautiful cacti in full blossom, also added interest.

*** This paper won for Georgia Hoffman the Best Girl Award at the annual Kansas Junior Academy of Science Meeting which was held in Manhattan, Kansas, last spring.**

that leaves on plants which grow under ordinary conditions are very wasteful of water, taking it up from the sap and giving it out to the air in a process called transpiration. Probably the first outstanding characteristcs noticed of cacti which is good to eat when stripped of its spines. The Indians call this fruit the Indian fig.

The giant cactus is the state flower of Arizona. Its average height is fifty feet. It has a dark green background covered with seven to ten rows of spines running perpendicular. The flower looks as if it had been dipped in white wax, but for one exception that its petals are covered with fine spines invisible to the eye.

The pincushion cactus is a native of Kansas. We find it on our Kansas plains. This cactus has a green background covered with brown and white spines. The average height of it is two inches. After a small white flower drops off, green

The organ cactus is found in the desert berries form, turn green and then red.
of Arizona. It grows in the shape of a pipe organ; it has a base about three feet high, covered with spines, and branches running up from it into the air about ten feet or more. A small white flower forms at the top of each branch.

The Christmas cactus is one of many spineless cacti. This house plant is green trimmed with red along the edges. It has a very showy flower which is brilliant red. The flower opens every day for about eight days.

The night blooming cereus is the only cacti that blooms at night. The leaves are dark green or brown covered with very few spines. The flower is generally white and about four to eight inches in diameter.

The fence cactus grows to a height of sixty feet. This cactus is green and covered with many spines. This cactus is called the fence catus because it is used for fences like our hedge fences.

THE ECONOMIC importance of cacti is great, especially among the primitive people. Some cacti provide food for man and beast. Along the Rio Grande in Texas grows a species known as the Mexican strawberry. The prickly pear is found on the coat of arms of Mexico. It is another type of cactus fruit. This flat leaf cactus contains a large amount of water and is often denuded of its spines and fed to cattle. The juice of the prickly pear has often served travelers in arid regions, taking the place of water.

We may think the cacti as unfriendly, yet birds often find them a refuge. Woodpeckers make holes in the giant cactus for their nest. Other birds move in these holes when woodpeckers move out. One of these is a small owl, said to be one of the smallest of all the owl tribe. Another feathered friend of the cactus is the cactus wren. The nest of a wren hole is entered by a coverway or neck several inches long, bored in one side of the cactus leading to the hole.

Juice is squeezed from the fleshy part of the Cancer cactus and is used to make medicines and liquors. Mexicans make candy from the juice of the same cacti. This candy is something like our taffy. Ropes are made from the strong fibers of many cacti.

I have enjoyed very much the research I have done to learn about cacti. I hope when you cross the desert you'll see beauty in these sturdy plants and that you'll realize that the thoroughly drained sandy soil and the desert air constitute Home Sweet Home for the cacti.

KANSAS ACADEMY

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Lawrence Junior High School, Lawrence
Lindsborg High School, Lindsborg
Madison High School Science, Madison
Manhattan High School, Manhattan
McCune High School, McCune
McPherson High School, McPherson
Nature Club, Uniontown
North High School, Wichita
Paradise High School Science Club, Paradise
Pittsburg High School Junior Academy, Pittsburg
Retorts Science Club, Merriam
Seaman Science Club, Topeka
Sherman Junior High Science, Hutchinson
Stafford Junior High, Stafford
Taxidermy Club, Columbus
Wichita East High Science Club, Wichita

Peace Time Explosives

RALPH K. CARLETON and SHELDON L. SALISBURY*

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THE TERM "explosives" is usually considered to be more or less synonymous with war. The explosives industry however, is essentially a peacetime manufacture which has played a vital part in world progress. Ranking the American chemical and allied industries according to the value of their products made in 19b0, the explosives industry would be placed about thirteenth in a list of thirty-one. This ranking does not include the related fields of ammunition and fireworks production and also excludes the numerous other products manufactured by companies whose original business consisted entirely of explosives manufacture.

Types of Explosives

The various kinds of explosives may be classified in a number of ways. For the purpose of this paper they will be put in four groups: black powders, high explosives, smokeless powders, and blasting initiators.

Black powders are the oldest type of explosives known, dating back to about the early part of the thirteenth century. Their origin is variously ascribed to China, Germany, and England, there being no clear certainty on the subject. Ir. England, Roger Bacon (1214-1294) is generally credited with the invention. Black powder consists of a mechanical mixture of sulfur, charcoal, and a metallic nitrate in the proportion found by experiment to give the desired results. A typical black powder for blasting contains about 75% nitrate, 15% charcoal, and 10% sulfur, together with small amounts of moisture, graphite, and an antacid such as calcium carbonate. For rifle powders, fuse powders, and other special uses, potassium nitrate is used in black powder manufacture because of its superior moisture resistance.

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Black powder is a deflagrating explosive, that is, it is fired by ignition and the gases are generated progressively as the burning speeds through the charge.

IN CONTRADISTINCTION to the burning type of explosives just described, high explosives are detonating explosives. They are fired by shock from an intermediate agent or detonator and the transformation from solid to gas takes place with extreme rapidity as the shock wave is transmitted through the explosive. This is essentially a chain reaction. High explosives include all dynamites, gelatins, permissibles, and the low powders. The development of high explosives which has taken place in the last hundred years, has been marked by the introduction of nitrocotton in 1845, nitroglycerin in 1846, detonators in 1864, dynamite in 1867, and gelatins in 1875. Most of these advancements emanated from Nobel, the Swedish chemist. Dynamites are mixtures of nitroglycerin and absorbents. The first dynamites made by Nobel used the inert absorbent kieselguhr, while modern dynamites contain combustible absorbents and other explosive ingredients. Dynamites are of several types known as straight, extra, low freezing, and so forth. At present almost all dynamites are low freezing, representing a most important step in the development of explosives, as in times past much trouble and many accidents were attributed to frozen dynamites. Straight dynamites are composed of nitroglycerin, sodium nitrate, wood pulp, and a small amount of an antacid. Extra dynamites are those in which ammonium nitrate partly replaces the nitroglycerin. Straight dynamites are quick setting and have a high shattering effect or brisance; extra dynamites have a slower speed of detonation and produce less shattering. Nitroglycerin may

be gelatinized by the addition of a certain amount of nitro-cellulose. Eight parts of nitro-cellulose completely gelatinize ninety-two parts of nitroglycerin and form a plastic colloid which is known as blasting gelatin. As the gelatins had many advantages over the dynamites, especially for wet work, means were sought to modify their explosive force so that they would be more generally useful. This was accomplished by adding various dopes to the gelatins and by using less nitrocotton in gelatinizing the nitroglycerin. These developments are known as gelatin-dynamites and are also quite plastic.

THERE ARE also the so-called "low" or bag powders, which are dynamites of low strength and are intermediate between black powders and the high-explosive dynamites. It is to be noted that the active ingredients of high explosives are based on the use of nitric acids esters and aromatic nitro compounds in general and nitroglycerin in particular. One class of compounds that has found commercial outlets is the nitrostarches. The nitrostarches overcome one objestion of nitroglycerin explosives in that they produce no headaches when they are used; however, they possess certain undesirable features and are not used extensively. Nitramon is a new development in the explosives field. This explosive consists of canned ammonium nitrate which has a small amount of sensitizing agent added to it and which is packed in the can to a definite density. This explosive is extremely insensitive and requires a special priming device to detonate it. On this account it possesses unusual safety features.

IN ADDITION to the classes of explosives described, there are various other types which appear on the market from time to time. Some of these are based on the use of potassium chlorate as the oxidizing agent and many of them have proved unsatisfactory and dangerous. It is interesting to point out that the perchlorates have largely replaced the chlorates because they are more stable and less sensitive, although they contain more oxygen than the chlorates.

The smokeless powders, which are propellants, consist essentially of two types, the single-base or solvent colloided nitrocellulose powders, and the double-base powders in which certain amounts of nitroglycerin are used along with the nitrocotton. In addition, inorganic nitrates, inerts, and stabilizers such as diphenylamine are added. The speeds of these powders may be varied and controlled by the use of accelerators (such as nitroglycerin) and of retardants which might be plactisizers or nitrocellulose. The powders are made in both fast and slow-burning varieties, the fast powders being used in shotgun shells, while the slower ones are for rifle and military propellants. The burning speeds are also controlled by the sizes and shapes of the powder grains or pellets.

THERE IS another class of explosive compounds known as detonating materials that has high brisance, velocity, and sensitivity. These materials are used to initiate the explosives, such as blasting and propellant powders. The detonating materials are used either alone or in mixtures, and are enclosed in caps or tubes, known as detonating caps, and detonating fuse for use with blasting explosives, and percussion caps for use with ammunition. The blasting cap usually contains mixtures of fulminate-chlorate or azine-nitrates; modern caps frequently have a base charge of a material such as tetryl, or nitromannite in addition to the irritating charge. The explosives used in detonating fuses are as powerful as those used in caps, but are relatively insensitive and require a cap for detonation. These fuses contain such compounds as (1) phlegmatized fulminate, (2) picric acid (melinite), (3) TNT tritol, and PETN (pentrit).

Manufacture of Explosives

THE MANUFACTURE of explosives in this country dates back to colonial times when the supply of powder could

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Concept Teaching in General Science

EDGAR BAILEY

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THE FIRST year of high school science includes the study of many of the principles of physics, chemistry, and biology. Examination of any General Science text reveals units on machines, light and sound, heat, electricity, combustion, etc. It has been argued that these are too abstract for high school freshmen to understand. Certainly there is plenty of difficulty in teaching them, if one attempts it on the same level and scale that he would use in teaching older students. Yet to eliminate the beginnings of science training in the freshman year is only building up trouble later on.

Every teacher knows the value of repetition. Few, indeed, are those who gain comprehensive knowledge from a "once-over" study of any problem. Mastery of a science subject may be likened to the removal of a drift by a snow plow. The first plunge into the drift makes only an opening crevice. Repeated drives into the same opening finally break up the obstruction, and a clear road is ahead. Just so, the first steps in science are opening wedges, but if these are shrewdly chosen, a vast amount of difficulty is avoided.

Running through all sciences are the threads of continuity which, if grasped in the beginning, will guide one's thoughts like the guiding skein by which the hero of Greek legend found his way from the labyrinth of the Minotaur. The threads of science are the basic concepts; they are based on solid experimental facts, yet they point to future discoveries.

IT IS APPARENT that concepts are in the nature of hypotheses. For example, "If heat is motion of molecules, and gas pressure is due to molecular impact, then gas pressure is due to heat." Such reasoning is the heart of science.

What has this to do with our first year science course? Simply this: try to inculcate in the course the basic concepts which are going to be repeated at a higher level in later courses, and present them in terms, and with apparatus, that are suited to the level of the students. If the concept is once grasped, the details and observations fall effortlessly int othe picture; otherwise, they are meaningless parts of an incomprehensible whole. Who has not seen chemistry students doing A, B, C and D in the manual, and then coming up with a conclusion which has no basis either in fact or in theory? The **concept** is the thing.

NOW TO POSE on actual situation. The teacher is presenting a unit on "Light" to a freshman science class. He has, of course, had advanced work in physics, and knows the problems which lie ahead of today's work. We will suppose that he is presenting the principle of lenses. Knowing that the concept of refraction leads to the mastery of all such problems, he concentrates on that.

First, he takes a smooth, square board, such as a checkerboard. Placing it flat on the table, he arranges several marbles along one edge. When this edge is lightly tipped, the marbles roll in straight lines to the other side, reaching it at the same time. The line of marbles represents the advancing front of light waves; each individual path may be called a ray.

He then covers the lower half of the board with sand paper, and repeats the experiment. Again the lines are straight, but the wave front takes longer to reach the other side.

He next shifts the board so that the marbles, rolling at the same speed, strike

the sandpaper obliquely. It is at once observed that the advancing line of marbles has changed its front; in other words, refraction has taken place.

Next, a light ray is thrown into soapy water. The refraction is at once apparent, and several tests will bring out the fact that the ray, when passing obliquely into the water, is bent toward the water, or more exactly, (this is important!) toward the perpendicular drawn to the surface of the water where the ray enters. The similarity to the marble experiment should be noted.

Undoubtedly, some member of the class will want to try the experiment on some substance other than water. Glass may be suggested. The instructor may send a ray of light obliquely through a square of plate glass, and the beam will be observed to come out in the **same** direction! "Aha!" says one student, "The thing isn't true in glass!" "Wait!" says a more careful observer. "The light is bent twice. I see the explanation." And here the teacher (thankfully) allows the bright pupil to explain the observed facts, and thus show that the converse of the "law of refraction" is also true.

AND NOW the class has reached the problem of the lens. The teacher will at this point call on many members of the class to state and restate the "principle" of refraction as learned by the foregoing inductive method. This is the generalization, and it should be phrased in several ways, the best being decided upon before continuing.

Now the instructor draws on the board a diagram showing three rays of light approaching a lens. One is perpendicular at the center and the others are on either side.

He will then call for predictions as to what will happen when each of the three rays enter the lens. It is apparent that the second ray will strike perpendicularly on the lens. Some pupils will have difficulty imagining a perpendicular to a curve. They may be asked "What is a smoke stack perpendicular to?" Since the earth's surface is a curve, they will see at once the similarity of this and the case of the second ray. Conversely, it will be seen that rays 1 and 2 strike the lense obliquely, as can be shown by drawing a perpen-
it.
dicular to the lens where the rays strike

FROM HERE ON, the students can easily calculate the approximate path of the rays, and predict that they will converge. The teacher now sets up a beam with chalk dust, and places in it a large convex lens. The focus is plainly seen, and a student's finger held in the focus for 30 seconds will give vocal verification of the prediction! The drawing shows the action.

Thus we have in this procedure the inductive method of arriving at a general law, and the deductive method of predicting a specific result, followed by an experimental verification.

The net result is a concept of the action of lenses which forms the groundwork for future studies along this line. It will be noted that the concept is not the inductive part only; neither is it the generalization, not the deductive application. It is composed of all of them. This is "whole" learning, as opposed to "piece" learning which is so often practiced. It is the writer's opinion that unless science teaching is based on this concept idea, it will fail of its purpose, which is to give the student the power of prediction.

THE PROCEDURE for teaching the concept of refraction and lens action as outlined above may take several days. When such procedures are followed, it will be found that no text can be completed in a year; probably not in two years. Many teachers of freshman science try to cover too much; it is better to concentrate upon the basic concepts of physical science and stay as far as possible from a program of covering a thousand pages. "Teach a little, and teach it well."

Science Fair

GEORGE CAROTHERS

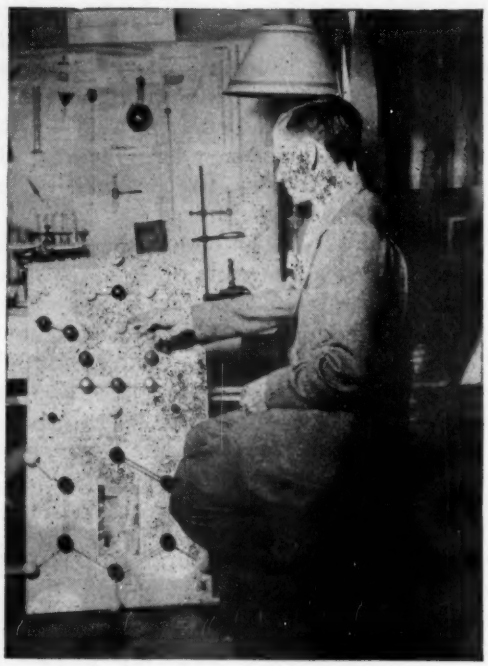
Roswell High School

Roswell, New Mexico

TO HOLD a science fair, each school will have its own individual problems. But in general, I believe that the plan worked out and used at Roswell Senior High School can be applied with some minor adjustments to any school science fair. The success of the plan may be seen from the fact that over 1,200 children visited the fair.

The science department, made up of four classes each of biology, physics, and chemistry, twelve classes in all, worked up the exhibits. Each teacher proposed possible projects that could be worked up into suitable exhibits.

The High School Science Club took over the active organization and management of the fair. The organization was started the first semester and actual work started early in the second semester.



Models of Atoms

Petroleum Products

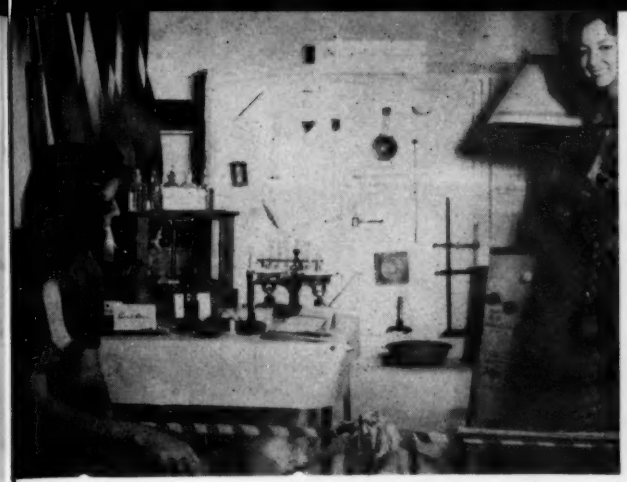
The first public notice was given in the following news item in the school paper:

ROSWELL HIGH SCHOOL
TO GIVE SCIENCE FAIR
Second one in the history of Roswell

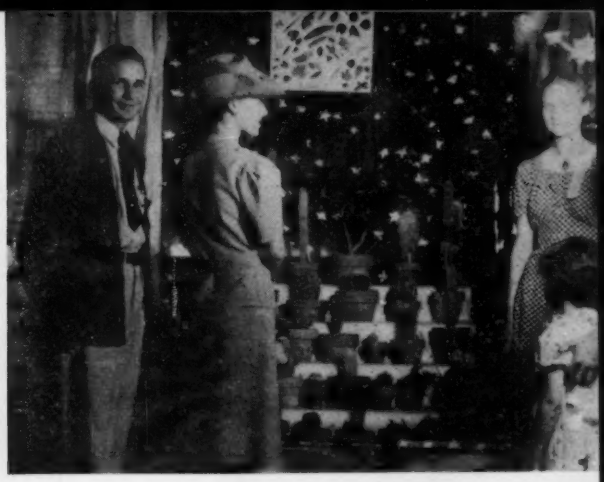
"All of the science departments, which include physics, chemistry, and biology, are joining together and producing a science fair to be exhibited the second and third of May, in the Roswell High School auditorium.

"In 1930 the high school organized and produced a science fair. It was proclaimed by many as a huge success and received worthy praise from various cities. The fair was composed of various projects made by the students and set up in booths in the same manner as state fairs are arranged.

"This year our friend Mr. George N. Carothers has again brought the idea of



Equipment in Chemistry



Rare Specimens of Cacti

the science fair to the students of Roswell. Due to the great enthusiasm built up by a review of the 1930 fair, and of the large number of students participating, this promises to be 'TOPS' as far as high school activities are concerned.

"Officers necessary for conducting this project have been elected by the executive members of the Science Club. They are as follows:

"President—Principal of high school.

"Vice-President—President of Science Club.

"2nd Vice-President — Vice-president of Science Club.

"Manager—Sponsor of Science Club.

"Assistant Manager—Physics teacher.

"Assistant Manager—Biology teacher.

Helpers

Electrical Engineer — Theme Center
Construction Engineer — Registration Booth
Transportation Eng. — Concession Booth
Publicity Manager — Chief Decorator
Artist (Sign Painter) — Location Engineer

All helpers are members of the Science department."

GENERAL INFORMATION FOR THE PUBLIC AND EXHIBITOR

Fair Date — May 2-3
Thursday and Friday

Place — Roswell High School auditorium.

Exhibits open to the public
Admission free

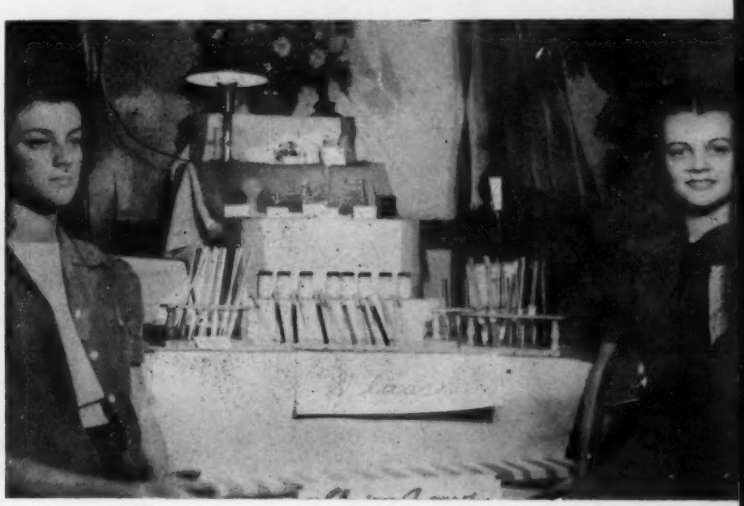
Open Thursday—Friday 8:45 a.m. to 9:00 p.m.

One exhibitor must be on duty from 6-9 p.m. each evening.

It is recommended that two students be in charge of one booth. The audi-

Picture Printing

Writing Materials



Model of Local Mine. Minerals of New Mexico.

torium will be open for construction of booths and placing of exhibits each afternoon at 3:15 beginning Friday, April 26th and will continue through until Wednesday evening, May 1st.

All exhibits must be in place by 7 p.m. Wednesday. No local commercial advertisements shall appear on any project. Exhibitors please leave auditorium when not working on your booth.

TO GIVE additional publicity, several articles were published in the local papers. The following proclamation appeared a few days previous to the fair.

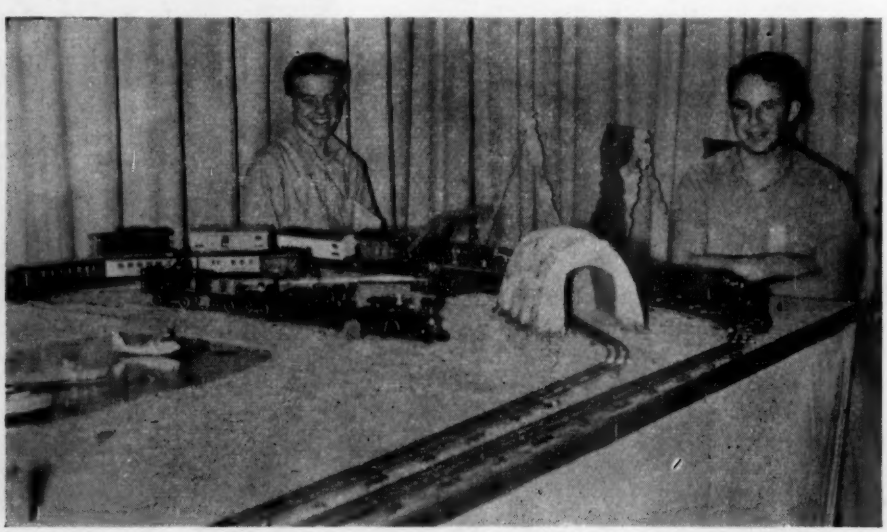
MAYOR'S PROCLAMATION

"I declare that Roswell Senior High School Science Fair is to be held on May 2nd and 3rd, 1940. The place is to be the Senior High School Auditorium. The Fair is to be open from 8:40 a.m. until 9:00 p.m., both Thursday and Friday. The public is cordially invited to attend at all times.

"No charge is to be made for any part of the fair.

"Profits from the concession stand are to be used to pay expense of the fair.

"Since this is the first Science Fair



Transportation shown by trains.

Foods and a Proper Diet

given since 1930, I declare that everyone, if possible, should see this fine and extensive exhibit of modern science."

THE FOLLOWING information was sent to various schools in and out of the city:

Superintendent of Schools

Dear Sir:

The science department of Roswell Senior High School is presenting a science fair in the high school auditorium May 2nd and 3rd.

The fair will be open continuously from 8:40 a.m. until 9:00 p.m. both Thursday and Friday. **Admission free. All exhibits free.**

Attractions

Every hour there will be a free sound motion picture on television and other scientific subjects. A large "Relief Map" of New Mexico will occupy the center of the auditorium. It will show the industrial and natural resources of the state.

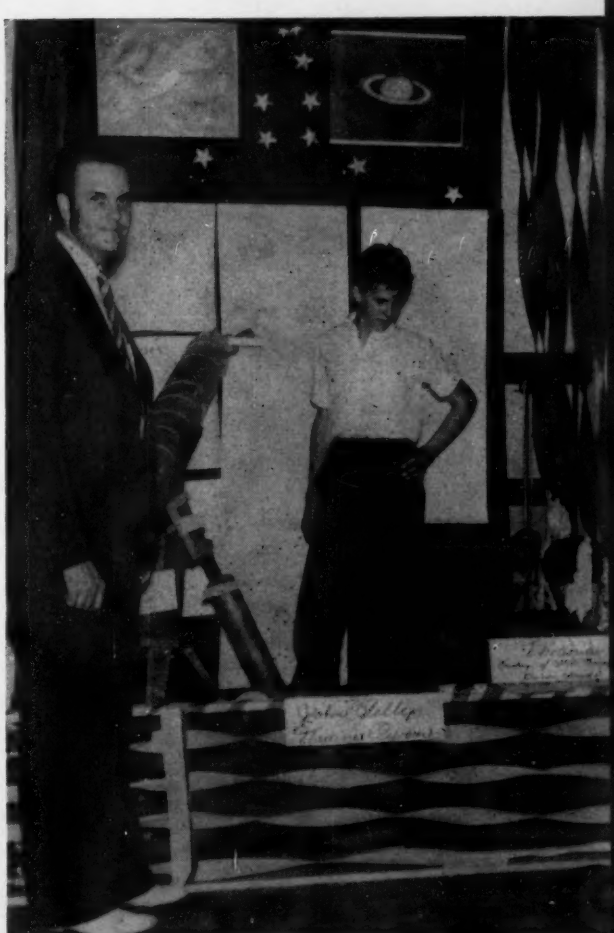
The entire auditorium will be decorated in gala fair colors. Music will be added to the festive occasion over the loud speaker system. The school band will give a concert on the high school lawn from 6:00 to 6:45 Thursday evening.

The following exhibits will be seen in the attractively decorated booths arranged entirely around the large auditorium. The exhibits include:

1. History of transportation including an electric train in operation. (Occupies the large stage.)
2. Transparent photography. Movie pictures and X-ray films.
3. Short-wave radio; W5GSD station.

(Continued on page 25)

A Six-Inch Telescope



Program

Physical Science Section of High School Conference

Urbana, Illinois, November 7, 1941

9:00 a. m., Physics Building

Chairman: E. L. Brock, Mt. Vernon High School

9:00 "Electron Microscope," a lecture-demonstration by G. L. Clark, Professor of Chemistry, University of Illinois.

9:30 "Modern Lighting and Color Analysis," an illustrated lecture by J. O. Kraekenbuehl, Professor of Electrical Engineering, University of Illinois.

10:30 "Science Teaching for Its Transfer Value," B. Othanel, Associate Professor of Education, University of Illinois.

11:00 "Chemists' and Physicists' Aids to National Defense," by an officer from Chanute Field, Rantoul.

12:00 Noon. Luncheon at the University Place Christian Church.
Speaker: Dr. John C. Bailar, University of Illinois. Topic: "The Improvement of Instruction in Chemistry."

Send reservations to Mr. Curtis Howd, University High School, Urbana, Illinois. Cost per plate will not exceed 65 cents.

Chemistry Section

under the auspices of

THE ILLINOIS ASSOCIATION OF CHEMISTRY TEACHERS

2:00 p. m., Physics Building

Chairman: Glen Tilbury, Urbana High School

2:00 "The Science Fair as an All-School Activity," John C. Chiddix, Normal Community High School.

2:15 "A Year of Chemistry in Eight Weeks," W. E. Harnish, University High School, University of Illinois.

2:35 "Opportunities for Growth in Science Teaching," Ray C. Soliday, Oak Park and River Forest High School.

2:40 "The Teaching of Chemical Principles Through Consumer Applications," Lawrence F. Tuleen, J. Sterling Morton High School.

3:00 "Inorganic Chemistry Helps in National Defense," B. S. Hopkins, University of Illinois.

Physics Section

2:00 p. m., Physics Building

Chairman: Dr. Dollahan, Pekin High School

2:00 "The Airplane's Debt to Physics," First Lieutenant Ned L. Reglein, Training Film Preparation Unit, Chanute Field, Rantoul.

2:40 "Rescuing Physics From the Textbook," E. H. Runkwitz, Representative of the University Science Co., Vincennes, Indiana.

3:15 "Demonstration and Display of Physics Projects," by students of Pekin Community High School.

Biology Program

under the auspices of

ILLINOIS BIOLOGY TEACHERS' ASSOCIATION

Natural History Building, November 7, 1941

Chairman: Madeline Dague, Danville High School

9:00 Announcements.

"Our State Parks"— a color film — address by Mrs. Eleanor Hemminger, Dept. of Public Works.

"Enriched Reading in Science According to Genesis" — Miss Bertram French, Librarian, Danville High School, Danville, Ill.

"Mental Hygiene," Dr. A. C. Ivy, Medical School, Northwestern University, Evanston, Ill.

12:15 Luncheon. McKinley Memorial Presbyterian Church, corner 5th and Daniel Streets, Champaign. Reservations should be made with Miss Ruth Ernest, Danville High School, Danville, Ill.

1:30 Business meeting.

"A Mind Mislaid," Mr. Henry Collins Brown, Founder of the New York City Museum.

"An Insect Looks at Mankind"— Dr. C. L. Metcalf, Dept. of Entomology, University of Illinois.

SCIENCE FAIR

(Continued from page 23)

4. Weaving samples of cloth and looms.
5. Mineralogy and geology of New Mexico.
6. Astronomy: a six-inch telescope and meteorites.
7. Plant specimens.
8. Animal specimens.
9. Foods: cocoa, malted milk, and corn products.
10. Glass: neon tubes, thermometer tube, pyrex, etc.
11. War materials: gas masks, cross section of shells.
12. Cacti; some very rare specimens.
13. Bones of animals.
14. Germination of seeds.
15. Complete equipment of chemistry desk labeled.
16. Water purification; Permutit process explained.
17. Photography; demonstration of picture printing.
18. First aid; various drugs.
19. Dyes; methods and samples; also blue printing.
20. Electrical exhibit; electrolysis; electroplating, etc.
21. Gypsum; snow white sands of New Mexico, Plaster of Paris, molds, etc.
22. Airplanes; various models; gasoline motors for airplanes.
23. Grafting; shows various types of tree grafting.
24. Weather bureau; equipment, and test balloons.
25. Sound equipment; sympathetic vibrations, types of musical equipment.
26. Vacuum pump; boil water at room temperature.
27. Petroleum products; a very large exhibit. A miniature oil rig in operation.
28. Writing materials; process of making lead pencils and fountain pen.
29. Fire prevention; models of various fire extinguishers.
30. Atomic structure; model of atoms and electrons.
31. Electrical currents; coils, transformers.

SCIENCE IN EDUCATION

(Continued from page 2)

The "graduate" training of biology teachers in the rural schools of Michigan was 10.0% biology and 39.6% of professional education.

Outside of New York City, reports from 110 high schools in the state, 3 — or 1 in 37 — report no biology taught.

Of the 2,472 teachers who answered this question 11.6% report that in their school a "social study has displaced a biological study during the past 5 or 10 years."

Somewhat less than 50% of those who replied to this question indicated that they teach evolution as the principle underlying plant, animal and human origin. Much opposition is disclosed from one or another community element — on religious or church grounds — and among the teachers themselves there is here a Fifth Column element of more than 10% and perhaps less than 20%.

Again, though many biology teachers throughout the country have a sound grasp of their obligation and opportunity to teach a science, the data obtained from many other teachers clearly show widespread tendencies to teach biology not as science but (a) as paths to pleasing hobbies or (b) as a series of practical technologies.

IV

TWO YEARS ago, before another group which met with the American Association for the Advancement of Science in Richmond, I said that "all high school teachers will give signal and lasting service to their country if they can hasten the day when it will be recognized that the first obligation of our high schools is to teach civics and manners, science and discipline." Repeating now and somewhat expanding that statement one may admit that teaching of some additional subjects of secondary importance may well also be done in those schools. But nothing better than world events of the past two years could show that the survival of democracy depends upon training in just these matters — civics and manners, science and discipline.

In times either of peace, of production for defense, or of war, those are basic safeguards of a democracy. Without information and patriotism obtained from training in the nature, quality and history of our democratic institutions we are an empty and tottering tribe whether in peace or at war. Our ill-manners and lack of discipline are at once the greatest obstacle to loving our neighbors as ourselves and to our readiness to march together in the hard tasks of national defense. Our lack of discipline — habituation to work, physical hardihood, sacrifice for ideals and subordination of self to a larger good — that is the huge vacuum into which the high hopes of democracy may disappear. What else than science can point the way and provide the instruments for either peace or war? How much could have been added of national and personal safety — to Americans, to Britons and to Frenchmen — by adequate training during the past 15 years in the physical sciences, mathematics, and the laws governing our living bodies? If this type of training, together with discipline and patriotism, had been given the youth or two or more of the stronger democratic nations may we not believe that the present assault upon world-wide democracy would not have occurred? With human nature as it is, and with irresponsible or bandit leadership of great nations occurring and recurring increasingly in our day, can any generation of democratic peoples afford to forget that vigilance is the real price of liberty? If, in the days ahead, the schools do not provide the human fiber which is the surest defense of liberty and democracy, how may that defense be provided.

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OTHER NEW SCIENCE BOOKS

Chemistry and You Chemistry and You in the Laboratory
New Chemistry Guide and Laboratory Exercises
New Learning Guides in General Science (for 7th, 8th, 9th grades)
New Physics Guide and Laboratory Exercises
A Learning Guide in Biology

LYONS AND CARNAHAN

CHICAGO DALLAS SAN FRANCISCO ATLANTA NEW YORK

TELEVISION

(Continued from page 7)

on a beautiful woman's head, which is enough detail to satisfy the average man; enough detail to be able to tell how well or how poorly the Clark Gables of television shaved before their television appearances — enough detail to satisfy the average American woman — or, possibly, too much detail. All of us at RCA felt that there would be a public demand for receivers as a result of the RCA television exhibits at both the 1939 New York and San Francisco fairs and that, consequently, we should engage in the manufacture of television transmitters, associated equipment and television receivers.

THE PUBLIC SALE of RCA television receivers began in the New York market the day the New York World's Fair opened up — April 30th — which was also the day regular television service was started by NBC. I'm sure that you will agree that, long after the New York World's Fair is forgotten, people will remember April 30, 1939, as the birthday of an established television service in the United States. The ultimate significance of the beginning of a television service in the United States will far transcend that of anything else that has taken place within our memory. If for no other eason than because television had its first large-scale public showing at the New York World's Fair, the New York World's Fair was aptly named the "World of Tomorrow," for the world of tomorrow will revolve around television.

During the first year of television broadcasting service in the New York area, approximately 3,000 television receivers found their way into homes, schools, restaurants, theatre lobbies and stores. These receivers were but a means to an end — the seeing and hearing of television programs. As to the ultimate success of television program service, let us take a look at what television offered to the owners of television receivers during television's first year. The programs fell into three main divisions of about equal importance. Events taking place outside the studio, studio programs and motion picture presentation.

IN POINT of importance, probably the number one position should be accorded to the telecast of President Roosevelt opening the New York World's Fair. It was an outstanding success. When King George and Queen Elizabeth visited the New York World's Fair, they graciously appeared before the television camera. Televiewers wrote many enthusiastic letters of appreciation about this unusual event. At the impressive ceremonies in the Court of Peace, at the New York World's Fair on Pan-American Day, the Hon. Cordell Hull, U. S. Secretary of State, headed an impressive list of State Department officials and influential members of congress who were telecast.

Sports enthusiasts in the area served by the New York transmitter, who either owned television receivers or who had friends who owned them, have had thrills aplenty in watching the various sports telecasts. In the Finnish track meet held at Madison Square Garden, nine world's records were broken and several more were tied. Hundreds of telephone calls poured into NBC after the games were over and all expressed the enthusiastic appreciation of televiewers. College and professional baseball and football games have been caught by the television eye and the action seen, as it took place, by thousands in the comfort of their own homes. Tennis, boxing, wrestling, bicycle races, fencing, soccer, basketball and ice hockey have each contributed its quota of interest to its ardent devotees who are television set owners.

THOSE WHO have been close to the television activities have naturally been disappointed by the relays, but they have not been disheartened. There are those in the industry who believe

that the best interests of television can be served by early commercialization of the art. There are those who take a different view, and to that view, of course, they are entitled. While it is not possible to definitely indicate the future course of television until television emerges fully from the laboratory and is put into full commercial use, it is possible to draw upon our imaginations as to what this new art can and eventually will contribute to our way of life.

First, television is going to be a great force in the extension and strengthening of democracy. We know, from experience, that democracy depends upon universal education of the citizenry. The citizens must have an understanding of the part that they should and must play in the functioning of a democratic form of government. This requires some understanding of the functioning of government. Television will be a great political mass educational force as well as, eventually, a specific educational force in the classrooms of our public schools throughout the nation.

WE ALL KNOW what a force radio has been in creating citizen interest in our national and local affairs of government. Each year since the advent of radio broadcasting a larger and larger percentage of our people have taken advantage of the greatest right of an American citizen — the right to vote. Political leaders in both of our major parties have given radio broadcasting the lion's share of the credit for this re-awakening of our citizens in their duties and obligations, particularly, the obligation to use the ballot if democracy is to be vital and strong. Television will multiply by many fold the political effectiveness of radio. Millions of our people on the Eastern Seaboard, as well as elsewhere, do not readily see the importance of such government projects as soil conservation work. A television program of a dust storm in action will drive home much more effectively than mere words the disaster that the nation faces if it allows its top soil to be blown away by the winds or washed away by the rains. By television, the constructive work of the CCC camps could be mirrored into the American home. In like manner all of the important activities of the government could be portrayed.

SOME DAY in our school rooms the classes on American Government will see their government in action. It is not impossible to visualize the day wren our school boys and girls will attend a Presidential press conference via television. It is possible that some day the television camera will invade a cabinet meeting so that school children can see the executive branch of our government in action. And from there, of course, the television camera would cover the sessions of the House and the Senate, the important committee meetings that are open to the public, government departments, etc. It is impossible to overestimate the power that television will some day be in preparing the boys and girls in our school system, for the responsibility which must be shouldered by them when they reach voting age.

ANOTHER development in television will undoubtedly take place within the next few years, namely, theatre television. Our company has conducted some experiments with pictures 9 x 12 feet in size and larger. It is possible that within the next two or three months we may make a demonstration to the theatre industry of this new equipment and the possibilities that the equipment offers to theatres, particularly, for showing those events where the results are not known until the final minutes of play. Out of the experience in building this equipment has come knowledge which should eventually enable us to design and manufacture projection television equipment for school use. It may be several years off yet, but anyone who has watched the progress knows that it is certain to come.

Large screen school television will make it possible for tens of thousands

(Continued on page 40)

SCIENCE VERSUS LIFE

(Continued from page 11)

also greatly increased the average life span, so that today society has a greater **percentage of members past fifty, sixty** and seventy years. To be sure, modern warfare tends effectively to counteract this "impact" of science on society. And it is not yet clear that the lengthening of the life span, particularly the effective life span, is an undesirable "impact." In brief, the alleged conflict between science and society is based largely on misunderstanding and on too sweeping generalizations.

The services of science to society are, primarily, increased knowledge and understanding. That such increased knowledge, understanding, and control of the forces of nature are used, not by scientists, but by society, with increasing effectiveness in the continuous and recurrent drives to satisfy greed, lust, hate and vanity, will, in my judgment, ultimately prove to be due, not to the inherent nature of the scientific method or of knowledge per se, but to the failure of man, so far, to be effectively conditioned by science and the scientific method.

THE EVIDENT failure of modern science to measurably influence human drives and conduct, individually, nationally, internationally, are probably to be sought in three factors: (1) the character of our prevailing education. Our prevailing education, starting in the home and in the church, in the grade school and the high, and extending into the college; is largely education by dictation. It is indoctrination rather than education by understanding the why and wherefore through experimentation. This applies to countries other than our own. There are those in our own country who insist all along the line on education by more and more dictation and indoctrination. Merely the memory of and the ability to repeat a heterogeneous number of facts, or even coordinated facts discovered by science, is not education in the method of science. Education demands the latest news on heredity, on the electron and the proton, on bacteria and health, on soil conservation, chemistry, and cancer; on birth control and pest control; on better foods, better homes, better children; and on a thousand other problems of life on which science has provided understanding and working out our control.

(2) Considerable responsibility for the failure of science to essentially modify human conduct must be laid to the scientists themselves. Many of us are scientists only during our working hours, and fall into the common errors of the average man when we step outside our own specific field. Many of us have considerable fog in our brains and clay in our feet, and this is discerned by leaders in other human endeavors, and by the man on the street. Scientists frequently become dogmatic both inside and outside of their own fields, and it may therefore legitimately be asked: if the very high priests of science thus fail to be influenced by the spirit and method of science, what hope can there be for the rank and file?

(3) The third factor is the tremendous resistance of man to new ways of thinking and new ways of life. During the past million years that man has evolved under the influence of the nonscientific or raw environment, he has developed emotions and habits and drives that are not easily, speedily or permanently modified by the environments and techniques developed by man himself through science. There is no use crying over this situation. It is one of the recognized scientific facts, and so must accordingly work toward the goal with longer vision and greater tolerance and patience. Science as an educational and social force is but of yesterday. Man has been exposed for ages to the fundamental ethics of the great religions, who use the elements of fear, punishment, and perpetual reward as motives, something that science cannot do. And yet the effects of this exposure seems neither signficant nor lasting. But, in our impatience, we so read-

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ily forget the element of time in animal evolution.

From all the evidence now available it seems clear that in the past greed, guile, and violence had survival value for primitive man. Assuming that these drives can be curbed on a national and international scale by the new **mores** based on understanding, reason, and emerging justice, will the latter have equal survival value in and for the kind of society we hope to build? My answer is yes, with this proviso: I think we must apply new and different measures to reduce the number of the less fit. We have enough information to make a beginning in that direction now, but prevalent mores prevent it. Unless reason based on understanding effectively guides social evolution of tomorrow in the direction of elimination or reduction in number of the less fit, those who cannot or will not strive for the individual and the common good, I see no escape from the degeneration that invariably follows biologic parasitism, except the ancient law of tooth and claw.

NOW, I SHALL try to say in one minute what I probably failed to make clear in fifty. As I see it, ours is not an age of science. Men are still driven by greed and confused by guile, rather than guided by reason based on our expanding knowledge. Science has greatly enlarged man's understanding, conquered many of his diseases, lengthened his life, multiplied his joys, decreased his fears, and added much to his physical comforts and powers. But man may use these and other achievements for a greater social injury, instead of for a further social advance. Science is specifically human, in that it stems from the innate curiosity of all men, and the conspicuously plastic brains of the ablest, if not the noblest, of our fellows. If this be so, it follows that the scientific method and its products

cannot be, in any fundamental and permanent sense, in conflict with human nature, though our present human society, product of a past dominated by greed, force, and fear, may be, and is in conflict with the scientific method. Whether science and the scientific method, whether understanding, honesty, reason, and justice can contrive survival values equal, if not superior to the blind forces of nature which shaped man's past, is as yet in the laps of the gods. Still, we cannot deny the possibility, and we will nurse the hope, that the hairy ape who somehow lost his tail, grew a brain worth having, built speech and song out of a hiss and a roar, and stepped out of the cave to explore and master the universe, may some day conquer his own irrational and myopic behavior towards his own kin.

I THINK we can say, even in the face of current pessism, that during the ups and downs of a million years man has gradually acquired more understanding, more freedom from fear, more dignity, greater kindness, and a clearer conception of justice. Even though for the moment, "the bird of sorrow" is not only flying over our heads, but is actually nesting in our hair — to borrow a Chinese proverb — that bird will not nest in our hair forever, even though a blackout on the light of science is decreed in every land. For, slowly, but surely, the method of science will help to make life more intelligent, toil more cheerful, fear and hatred, pain and tears less prevalent in our lives. If in any place or time the blind fury of hatred of our brethren, and the insane violence of war render the pursuit of science impossible, and the scientific method submerged and forgotten, it will be rediscovered, in better days, by better men.

Revised Edition — Off the Press in August . . .

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RADIO AND THE BIOLOGY TEACHER

(Continued from page 9)

Listening to the Broadcast. In actual listening the situation should be such that the listeners have a profitable experience. All distractions should be elimtions as well as distractions from within tions as well as distractionsfrom within the classroom. An attentive-listening listening teacher is one of the best assurances that the students will listen attentively. If maps, blackboard illustrations, exhibits, and the like are to be used during the broadcast, a pointer may be useful. It is generaly recommended that students not be required to take notes during the broadcast, but there are times when note-taking is helpful. The teacher will generally find it desirable and useful to keep note-taking materials at hand for his own use. On occasions the students might want to jot down questions, or other items which they want to discuss after the broadcast. It has been found that it is not necessary for students to sit at rigid attention to hear and understand the program.

Following the Broadcast. After the listening, then comes the artistry of the teacher in relating the material presented in the broadcast to his particular course of study. Discussion generally begins immediately after the broadcast and the chief task of the teacher is to guide the discussion along fruitful channels. The listening may stimulate the students to want to read, to want to talk, to participate in experimentation, take field trips, or other types of activities. If the teacher cannot add to the effectiveness of the broadcast in the follow-up period it is probably better to go along to the other undertakings of the period. If it is found that the teacher frequently must devote considerable time in saving the broadcast as a worthwhile educational experience, this is sufficient indication that the broadcast should not be used.

(Continued on page 40)

EXPLOSIVES

(Continued from page 17)

no longer be obtained from England and when it came into great demand. Thus numerous black powder plants were erected mainly in the eastern part of the land. As the general development of the country took place westward, powder manufacture likewise went westward, until today there are explosives plants located all over the nation. These plants, however, are usually located so that they are near various mining operations, which are the largest users of explosives In 1936 there were twenty-two different manufacturers of explosives in the United States, operating about seventy-four plants. The greatest concentrations of these plants were in Pennsylvania (ten per cent), California (ten per cent), and Illinois (five per cent). On account of the nature of explosives, the plants are always located in rather isolated spots so that they are not a menace to the surrounding territory, and likewise so that their surroundings are not detrimental to them. Locations are chosen, if possible, that have natural barricades, such as hills, slopes, and so forth; however, if natural barricades are not present, artificial ones are placed around each building so that explosion in one building will not be communicated to the others. The nitroglycerin plant is frequently used on a hill so that gravity flow may be used. Locations are selected first with a view to safety, and second to economy of operation. This is also true of the magazines in which the explosives are stored. The distances between buildings are governed by the American table of distances, set up by the Institute of Makers of Explosives.

ONE HEARS a great deal about materials of construction, and in an explosives plant not only a knowledge of materials is required but also sufficient engineering to construct the buildings themselves and the equipment in them. Here again the factors of safety and economy of operation govern design. The buildings are so designed that, should an explosion occur, a minimum of damage will result. This is accomplished in various ways, one of which is to build rigid or reinforced walls, and to have a light roof. The inside walls will be smooth so that dust will not accumulate, and they may also be curved and shaped. If an explosion occurs, the walls will deflect the explosive wave so that it will be away from the operators and equipment and will blow off the roof or other lightly constructed section. Barricades are also placed around machines; in some operations the machines are operated from behind barricades, using a system of mirrors to view the operation if this is necessary.

In the explosives industry plant and health hazards are watched perhaps more closely than anywhere else, and every known precaution is taken. As already described, great care is taken in selecting the plant location, and in the plant buildings and equipment. Special caution is exercised on all moving parts, and equipment drives, such as motors, are explosion proof and in addition usually placed in separate buildings from dust and accumulations of waste materials: hence the name of "white area" or "clean area" for the parts of the plant in which explosives are actually made. Matches and cigarette lighters are not permitted to be carried into explosives plants and must be deposited at the entrance where they can be reclaimed on leaving. All plants are guarded by watchmen and are enclosed by fences. All workmen in danger areas wear special shoes or rubbers and special clothes or overalls changed before leaving the plant. Some operations, such as incorporating or wheeling black powder, are always conducted without an operator being present in the building, the machine being controlled from remote switches. In other operations, the number of men present is limited.

NITROGLYCERIN, for example, has a powerful physiological action which

causes violent headaches, either from handling it when it is absorbed by the skin, or by breathing the vapors, because it is slightly volative at ordinary temperatures. Most persons engaged in nitroglycerin explosives work rapidly establish an immunity to its effects, although this immunity is quickly lost by an absence of a day or two from nitroglycerin work, and must be reestablished when the work is resumed. The aromatic nitro bodies have definite toxic effects and great care must be observed by the workmen in their manufacture. Some of these nitro-compounds, such as picric acid (TNT), color the skin and hair yellow, which color cannot be washed off but will gradually disappear when absent from the picric acid. These compounds also produce a dermatitis in certain people who have sensitive skin. It is, therefore, apparent that the management and the workers of an explosives plant must be continually on the alert to prevent any of these various potential plant and health hazards from becoming realities. That they are successful in doing this is attested by the splendid records of their low accident and occupational disease rates.

Black powders are made much the same way today as they were one hundred years ago. However, some technical changes have taken place, such as improvements in the type of equipment used. The so-called "flow-plan" methods of manufacture are employed to produce black powder and nitroglycerin. A typical flow-plan for the manufacture of nitroglycerin dynamite might be outlined as follows. The glycerin and mixed acid are added to a nitrator fitted with cooling or refrigerating brine coils. A drowning tank is always placed below the nitrator so that the entire charge may be quickly emptied into it should the reaction become uncontrollable. Following the reaction, the nitroglycerin and spent acid goes to a settling tank for removing traces of nitroglycerin and then to the acid recovery system. The nitrogly-

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cerin goes to a water washing tank, then to a neutralizing tank containing sodium bicarbonate solution, and finally to a storage tank.

AS PREVIOUSLY mentioned, dynamites consist of nitroglycerin and various other absorbent and explosive ingredients. These other ingredients, termed "dope," consist of wood, flour, sodium nitrate, sulfur, etc. All the dope ingredients are weighed out and then placed in a suitable drier; after drying they next go to the dope mixer. The dried and mixed dope and nitroglycerin are then brought together in a dynamite mixer. These mixers are made of wood, bronze, or other nonsparking materials and contain mechanical agitators. In the manufacture of gelatins and gelatin dynamites the operations are similar to those described except that the nitroglycerin is first colloided with the nitrocotton by agitation and heat. The jelly is then taken to the mixer.

After the mixing the dynamite or gelatin dynamite is ready for cartridging. Paper cartridges are formed on a special machine which crimps one end and permits the other end to remain open. The cartridges are usualy paraffined and then taken to the pack houses. Packing in the cartridges is now accomplished automatically for both dynamites and gelatins, although most of the gelatins were formerly handpacked. A Hall-type dynamite packing machine is constructed mainly from wood. This machine has a member rotating on a horizontal axis and contains four chambers on shuttles. The rotation of the shuttles is intermittent by quarter turns; the sequence of the operation is inserting the paper shells, packing them from above with dynamite, closing and folding the ends of the cartridges, and removing the filled and crimped cartridges. The daily output of one of these Hall machines is quite high.

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need. Quinine may not be as pleasant as chocolate but in the treatment of malaria it is far more efficacious. There is much to be said for their argument. However, there are many instances on record when the removal of impurities from a drug has improved its efficacy and even its taste; and the administration of many a bitter pill has been eased by a chocolate coating. Lest I be accused of labelling any part of an elementary science course an impurity, let me hasten to add that the classification of certain ingredients in a mixture as impurities is based on the purpose for which the mixture is used. Thus, certain topics which are essential ingredients in a chemistry course for future chemists, may be of little value to a liberal arts student.

Before a teacher finally makes up his mind to take the firm stand that the same type of elementary science course is best for all kinds of students, let him examine his motives objectively. It is always easier to repeat than to change. The technique of administering the traditional course has been perfected over a long period of time by the trial and error method. Many texts and laboratory manuals are available. The material covered is so familiar to the teacher that lectures rarely have to be prepared before they are presented nor have original sources to be consulted. The task of winnowing, classifying, and integrating the subject matter available for a new type of course is not to be undertaken lightly. Finally, the possibility of failure in any new attempt looms large.

ON THE LEFT wing we find a humble but enthusiastic group of teachers who may be only too willing to admit the fault of the majority of their colleagues to escape the sting of the criticism hurled in their direction; and perhaps too eager to do something different merely to escape the boredom of teaching the same material year after year. These have been sending questionnaires to laymen and to

other teachers asking them to rate certain topics as to their importance and interest to students in general. The answers are now available. Toothpastes, mouth washes, laxatives, and talcum powders by all means, but no theory! Theory is "not considered worthwhile." Shades of Michael Faraday, of Thomson, of Rutherford, and of Pasteur! Theory is the guiding light which leads modern science to the solution of its problems.

Here again motives must be carefully questioned. If theory be omitted, the task of the teacher will be lightened considerably. Facts need not be interpreted but only learned. The use of memory alone and not of reasoning would be sufficient in such a course. Fortunately, an up-to-the-minute text is readily available in the bulletins published monthly by organizations which test commercial products for the benefit of consumers. Lecture demonstrations of the preparation of cold creams and tooth pastes can easily be devised. But is this education or entertainment? Can this type of course ever rise above a mere cataloging of what is good and what is harmful in today's markets? How can the students be led to understand the achievements of organic chemistry, for example, with no knowledge of molecular structure? Chemists would become modern Aladdins in the wondering eyes of the students. Rub the test tube and out pops a pair of nylon stockings! Perhaps I'm growing old too rapidly but I find myself profoundly shocked by such an educational heresy.

Many of us feel that the best that science can contribute to the education of an individual is in cultivating the appreciation and even the practice of that type of clear analytical reasoning by which science attacks and solves its problems. In perhaps no other field of learning is such practice available to the degree to which it has been applied in the natural sciences. The logical reasoning by which a theory is derived from a group of related facts can be presented with all the appeal of a detective story. The application of such a theory to the solution of practical problems can be made as interesting as the story of the success of a general, a financier, or a statesman. Intellectual satisfaction comes to those students who have followed the reasoning which leads to an important and a useful theory. Their conception of their environment is enriched by this penetration below the surface of things as they appear.

The outline for the topics discussed in a course of this type in chemistry can be built around a study of the structure of matter from the subatomic particles to the giant molecules. Many and varied practical applications can be introduced throughout the entire course from the use of the cyclotron in transmutation to the production of plastics, nylon, and synthetic rubber and the isolation of pure viruses. Such a course would challenge their intellects as well as be an addition to their store of information.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933

Of The Science Teacher, published 4 times per year at Normal, Illinois, for October, 1941.

STATE OF ILLINOIS, County of McLean, ss.

Before me, a notary public in and for the State and county aforesaid, personally appeared John C. Chiddix, who, having been duly sworn according to law, deposes and says that he is the owner of The Science Teacher and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:
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Sworn to and subscribed before me this 11th day of October, 1941.

Wesley Wilcox.

(SEAL) (My commission expires Apr. 5, 1942.)

BOOK SHELF

Test It Yourself. Lawrence F. Tuleen, Willard L. Muehl, and George S. Porter, J. Sterling Morton High School and Junior College, Cicero, Illinois. Scott, Foresman and Company, Chicago, Illinois, 1941. 290 pages. 96 cents list; Teacher's Edition, $1.08.

In Test It Yourself we have a very useful and practical chemistry laboratory manual that should meet the demands of those who want to use the consumer approach. Chemical principles can be taught in situations that are truly those of every day life.

Undoubtedly the book will make laboratory work more interesting for the pupils. Its experiments deal with things people use — food, drinks, cosmetics, antifreezes, inks, soils, etc. The problems raised are of real concern to the student. Further, he must do the experiment to arrive at a conclusion, instead of just finding the answer in the text. The student learns to apply the principles of chemistry and not just to demonstrate them.

Test It Yourself is organized so as to fit with most chemistry texts and may be used as a complete laboratory course or as a supplement to the laboratory work of any chemistry course.

Among other noteworthy features the book has keyed references to 14 of the most usually used texts; it has adequate laboratory helps to guide the pupil in the use of apparatus. and it comes with a spiral binding that allows the book to lie flat on the desk. In use, the teacher will find that after the first three experiments the pupils may follow their own interests and take the experiments in any order. This should enable the student to get the utmost in satisfaction from the course.

Tours Through the World of Science. William T. Skilling, State Teachers College, San Diego, California. McGraw-Hill Book Company, New York, 1941. 815 pages, 371 pictures and diagrams. $1.70, list.

In the latest edition the author has brought this well known general science text in line with recent thought and educational practice in the field. In all his tours, whether among "rocks and minerals, electricity in modern daily life, or how plants live and how we should treat them," he presents in a simple, interesting and logical way the human problems involved and the facts pertaining to them.

The areas covered are the usual ones in the year of science, but they are developed in a different way. Paragraph headings are intended to give a complete analysis of the thought of the book and they do this quite well. Experiments and demonstrations are placed with the paragraphs to which they are related and give the student the necessary experiences for understanding. The thought questions which follow the experiments will often lead to real independent thinking and to a necessity for getting facts by experiment. Suitable topics for written exercises are listed as also are challenging topics for discussion. The book should prove interesting to students and in the hands of the average teacher should provide a satisfactory background of information for the science course.

The Earth and Its Resources. Vernor C. Finch, University of Wisconsin; Glenn T. Trewartha, University of Wisconsin; and M. H. Shearer, Westport High School, Kansas City, Missouri. McGraw-Hill Book Company, 1941. 634 pages, 421 pictures and drawings. $2.40, list.

To meet the needs for a physical geography in the high school is the objectives of the authors of The Earth and Its Resources. Writing on the high school level they present the basic facts upon which may be based a real understanding of the all important subject of conservation so much emphasized at present. Also they present the facts concerning the differences in environment that are basic to an understanding of pressing economic and social problems.

The organization of the book is simple. The major features of the earth are first considered as separate topics and

second in relation to the different regions of the earth. They are discussed under the main headings: "(1) the atmosphere: weather and climate; (2) landforms: plains, plateaus, hill country and mountains; (3) the oceans and their shores; (4) earth resources: waters, vegetation, soils and minerals."

The book is well written, suitably illustrated, and contains enough diagrams to make clear the text. The questions at the end of chapters afford a good review. Many suggestions also are suited for desirable activities.

The book is a definite step forward in providing a serviceable text for a functional course dealing with the physical world.

A laboratory manual to accompany the text has been prepared by the authors. It permits the course to be handled on the same basis as other laboratory sciences. Enough exercises are provided for two semesters of work.

RADIO AND THE BIOLOGY TEACHER

(Continued from page 33)

THE IMPORTANCE of reading the teacher manual before the broadcast cannot be overemphasized. In studies that have been made of the use of teachers manuals, it has been found that nearly nine-tenths of all teachers who use school broadcasts regularly also study the manual before each broadcast.

Use of Recordings

Although recordings would eliminate many difficulties, no extensive discussion is made of their use because of the paucity of available recordings. Some schools which have adequate recording equipment make recordings as the programs are broadcast then play the records to the students as they fit more closely the class activities. This seems to be a good plan for those schools having satisfactory recording facilities.

Sources of Information

1. Local newspapers. 2. Local radio stations.
3. Directors of local "Schools of the Air."
4. Mr. Sterling Fisher, director of education, Columbia Broadcasting System, 485 Madison Avenue, New York City.
5. Dr. Rowland Angell, Educational Counselor, National Broadcasting Company, Radio City, New York City.
6. **Movie and Radio Guide** magazine, 731 Plymouth Court, Chicago, Illinois, or any news stand.

TELEVISION

(Continued from page 29)

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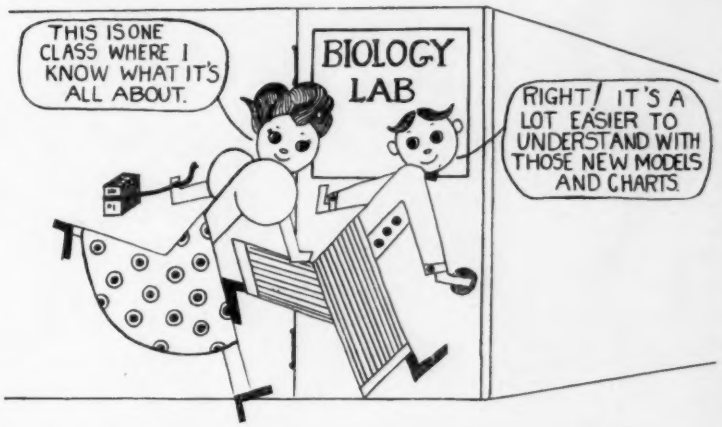
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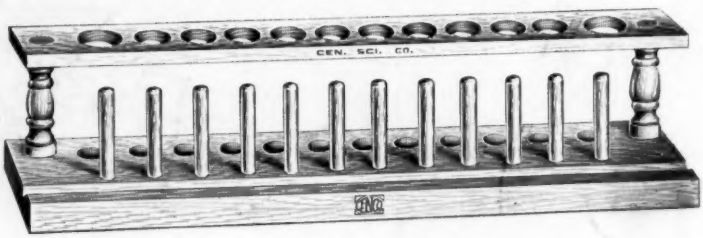

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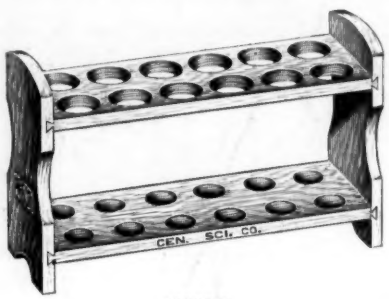

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